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(12) # EUROPEAN PATENT SPECIFICATION

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(54) **Reinforcing member and reinforced panel comprising it.**

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(73) Proprietor: **NISSAN MOTOR CO., LTD.**
No.2, Takara-cho, Kanagawa-ku
Yokohama-shi Kanagawa-ken 221 (JP)

(72) Inventor: **Miura, Toshikatu c/o Nissan Motor Company, Limited**
Ogikubo Plant 5-1, Momoi 3-chome
Suginami-ku Tokyo (JP)
Inventor: **Nagata, Yukio c/o Nissan Motor Company, Limited**
Ogikubo Plant 5-1, Momoi 3-chome
Suginami-ku Tokyo (JP)
Inventor: **Okada, Yukio c/o Nissan Motor Company, Limited**
Ogikubo Plant 5-1, Momoi 3-chome
Suginami-ku Tokyo (JP)

(74) Representative: **Patentanwälte TER MEER - MÜLLER - STEINMEISTER**
Mauerkircherstrasse 45
D-8000 München 80 (DE)

Courier Press, Leamington Spa, England.

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Description

Background of the Invention

This invention relates to a reinforcing member and a reinforced panel.

Weight reduction is desirable, for instance, in the automobile field, for resource-saving and energy-saving purposes. If weight reduction is achieved by decreasing the thickness of parts, or by reducing the number of components, strength is decreased. As a result, automotive body panels, particularly in doors, may have numerous weak points. The strength, and particularly tensile strength, of the outer panels may be significantly decreased. This results in poor door handling feelings for passengers.

Accordingly, it is necessary to develop a suitable reinforcing member. Reinforcement with heavy sheet metal is contradictory to the purpose of weight reduction. Thus, it has been proposed to reinforce the door outer panels or the like entirely or partly with a light resin sheet.

However, because prior art resin reinforcing have previously been just a thin resin sheet adhered onto an outer panel of a door, they have been nearly useless from the standpoint of increasing thickness and strength. If the thickness of the resin sheet is increased, then weight is increased. If packing is used between the resin sheet and the inside of the door outer panel to increase the thickness, then the resin sheet cannot be securely attached to the panel and the structure is more complicated than necessary.

A further prior art reinforcing member which can be used for additional reinforcing of sheet-metal parts at vehicle body members is disclosed in US—A—3 185 266. It comprises a strip or profile member of unvulcanized rubber mixture having a cross-section corresponding to the spacing between a reinforcing sheet metal layer and an outer covering body panel. During vulcanization, the rubber mixture expands, i.e. during the paint drying operating of the vehicle, and, by reason of its internal stresses, squeezes into the space between the connecting surface. This prior art reinforcing member has also a heavy metal sheet which has to be adapted to the shape of the outer covering body panel. The distances due to large tolerances have to be adjusted by a larger rubber strip. This prior art reinforcing member has therefore also the disadvantage of a heavy metal sheet which has to be preformed according to the shape of the outer panel.

Summary of the Invention

A reinforcing member includes a reinforcing resin sheet which is unhardened or semi-hardened to be flexible prior to its use, a high tensile-strength fiber for reinforcing the resin sheet along its longitudinal direction, a low tensile-strength fiber for reinforcing the resin sheet in its transverse direction, and a strip of expandable material narrower than the resin sheet. The expandable material is flexible at least before the reinforcing material is applied. The expandable material is made of a material which can form a bead-like projection before the resin sheet is hardened. The expandable material is fixed to the resin sheet. The resin sheet has its edge portions extending beyond the expandable material so that the underside surface of the edge portion constitutes a surface which can be bonded to the panel.

A panel such as the outer panel of an automobile door is reinforced by the reinforcing member.

Brief Decription of the Drawings

Fig. 1 is a perspective view showing a reinforcing member according to a first embodiment of this invention;

Fig. 2a shows the reinforcing member shown in Fig. 1 as attached to a panel before expansion and hardening;

Fig. 2b is a cross-sectional view of the reinforcing member shown in Fig. 2a;

Fig. 3a shows the reinforcing member corresponding to Fig. 2a, after expansion and hardening;

Fig. 3b is a cross-sectional view of the reinforcing member shown in Fig. 3a;

Fig. 4a is a perspective view of a reinforcing member according to a second embodiment of this invention;

Fig. 4b is a cross-sectional view of the reinforcing member shown in Fig. 4a;

Fig. 5 is a graph of the load-displacement relationships of some combinations of reinforcing fibers used in the reinforcing member according to this invention;

Fig. 6 is an elevation view of a vehicle door showing the positioning of the reinforcing member according to this invention; and

Fig. 7 is a cross-sectional view of an automobile door reinforced by a reinforcing member according to this invention.

Detailed Description of the Preferred Embodiments

Figs. 1 to 3 show a first embodiment of this invention. Figs. 1 and 2 show the case in which the reinforcing member has not been heat-treated. Figs. 3a and 3b show the case in which the reinforcing member has been heat-treated to expand.

Referring to Figs. 1 and 2, a reinforcing member 1 includes a reinforcing resin sheet 2 and an expandable material 3. The strip of expandable material 3 is narrower than the resin sheet 2 and is sandwiched between the panel A and the central portion of the resin sheet 2 so that the edges 21 of the resin sheet 2 remain free to be adhered to panel A at positions 22.

The reinforcing resin sheet 2 is preferably made of a thermosetting resin such as a thermosetting epoxy resin but is not strictly limited thereto. For instance, the resin sheet 2 may be melamine-, phenol- or urea type resins. The resin sheet 2 may be made of a resin which can be

hardened at room temperature or a thermoplastic resin which has the desired strength at normal temperatures.

The reinforcing resin sheet 2 is in a semi-hardened or unhardened state when affixed to panel A in order to be suitably flexible. If it is attached to a vertical plate as shown in Fig. 2b, it preferably would be adhesive. Otherwise, the resin sheet 2 can be fixed to the panel by means of other adhesives.

The reinforcing resin sheet 2 includes high tensile-strength fibers, such as stainless steel fibers, carbon fibers or the like, in its longitudinal direction, mainly for the purpose of increasing bending strength, and with a low tensile-strength fiber, such as cotton, nylon, polyester or the like, in its transverse direction. Such a fiber or fibers can be added in any form, for example, by adhering them to the resin sheet 2 or embedding them in the resin sheet 2.

The expandable material 3 is preferably a foamable material such as a foamable polyethylene sheet, which is flexible prior to expansion and expands when heated. Examples of such an expandable material are thermoplastic resins thermosetting resins, or foamable resins which are porous at room temperature.

The projection 23 might also be made of a previously expanded material, such as flexible corrugated cardboard or rope.

As shown in Fig. 2, the edges 21 of the reinforcing member 1 are bonded to the panel A so that it is fixed to the panel A. Since the reinforcing resin sheet 2 and the strip of expandable material 3 are flexible, they can be properly affixed to the panel A even if their combined shape is irregular. Then the panel A and the reinforcing member 1 are heated together. The resin sheet 2 becomes temporarily less viscous so that it will be become even more firmly bonded to the panel A. The expandable material 3 expands to stretch the resin sheet 2 and will expand to conform to the stresses in the resin sheet 2 during this heat treatment.

Because the resin sheet 2 is reinforced with the low tensile-strength fibers in its transverse direction, it can easily expand in accordance with the expandable material 3 without separating the resin sheet 2 from the panel A. When the reinforcing member 1 and the panel A are further heated for a predetermined period, the reinforcing resin sheet 2 is hardened. As a result, the reinforcing member 1 shown in Fig. 3 can be obtained, which conforms closely to the shape of panel A.

A previously-formed projection can be fixed to a reinforcing resin sheet 2 before the combined structure is attached to a panel.

Fig. 4 show a second embodiment of this invention. The reinforcing resin sheet 2 consists of two layers: an outer layer 24 of a reinforcing resin reinforced with or fibers and an inner layer 25 of a relatively soft resin which can be heat-treated to expand and harden to a desired degree. In addition, a film 26, such as a polyester film or the like, is fixed to the outer surface of the reinforcing sheet 2. The edges of the soft resin layer 25 are bonded to the attaching surfaces 22. In addition, a rust-proofing coating 4 is applied to the surface of the panel A. The expandable material 3 is the same as in the first embodiment.

The soft resin layer 25 is intended to minimize local strain or sagging of the panel A resulting from the resin expansion and contraction. Therefore, it need only be used at the bonding positions 22.

If the resiliency of the soft resin layer 25 is too low, the reinforcing effect of the reinforcing member 1 decreases. However, since the degree of local strain or partial sagging of the panel A is dependent on the thickness of the panel A, a required resiliency of the soft resin layer 25 can be predetermined. The soft resin layer 25 may be used in conjunction with a tough or hard resin layer which is not reinforced with fibers.

The film 26 is added to prevent the resin sheet 2 from adhering to other parts during handling when the resin sheet 2 has an adhesive character. Powder can be used in place of the film 26 for the same purpose.

The rust-proofing coating 4 may be a zinc-treated coating or painting.

Incidentally, the added materials or members in the second embodiment can also be used in the first embodiment.

Fig. 5 shows the results of experiments with respect to various combinations of low tensile-strength fibers and high tensile-strength fibers for reinforcing the resin sheet 2. A 10 mm height of bead-like projection is formed on a 0.7 mm thick steel panel as a test piece. The line A represents a load-replacement relationship in the case wherein the resin sheet is reinforced with stainless steel fibers in its longitudinal direction and fiber glass fibers in its transverse direction. The line B represents the analogous relationship in the case in which the fiber glass fibers are used in the longitudinal direction of the resin sheet and nylon is used in the lateral direction thereof. In the case of line C, fiber glass fibers are used in both the longitudinal and transverse directions. In the case of line D, only the 0.7 mm thick steel panel is used.

As can be seen from Fig. 5, the bending strength is hardly affected by changing the fibers used in the transverse direction of the resin sheet. As compared with the naked steel panel, the reinforcing member of this invention remarkably improved the strength.

Figs. 6 and 7 show a panel reinforced by a reinforcing member according to this invention.

A panel 5 serves as an outer panel of an automobile door. Since the panel 5 is relatively flat, if the thickness of the steel panel is decreased, the strength decreases so that the desired tensile strength of the outer panel may not be obtained. Thus, the outer panel can be easily deformed, and the door handling feelings are poor.

The panel 5 is supported at its upper edge 51, lower edge 52, front edge 53 and rear edge 54 by an inner panel or the like so that the strength of the panel 5 is high at those edge portions. It is

also high at a character line 55 due to the thickness of this section. Therefore, it is necessary to reinforce the center of the upper portion of the panel and portions adjacent thereto. If reinforcing member were attached only along the center of the upper portion of the panel, the desired strength would not be obtained because there would still be no means for securing the upper portion to the rest of the panel.

In the example of Fig. 6, the reinforcing member 1 is disposed between the upper edge 51 and the character line 55 which are relatively strong whereby the relatively weak upper portion is reinforced by the reinforcing member anchored by the highly rigid edge portion and character line. The reinforcing member further extends to the lower edge 52 to improve the strength of the intermediately rigid portion between the character line and the lower edge. Also, the reinforcing member 1 is disposed between the front edge 53 and the rear edge 54 along the horizontal axis of the upper portion to increase the strength of the weak upper portion of the panel. Thus, the panel is thoroughly strengthened.

In the embodiment of Fig. 7, the reinforcing member 1 is placed between the upper character line 56 and the lower character line 57 to increase the strength of the intermediate flat portion 58.

If the reinforcing member 1 is arranged as in the above-stated examples, the load exerted on the less-rigid portions is transferred to the more-rigid portions through the reinforcing member 1. Thus, the strength is remarkably increased.

Incidentally, the reinforcing member can be arranged in any form to the panel to be reinforced. For instance, it can be arranged in a linear, curved or cross pattern.

According to this invention, since a reinforcing member is flexible prior to its use, it will conform closely to the shape of a panel so that the reinforcing member can be securely bonded to the panel. No additional shaping is necessary prior to use. Before it hardens, a bead-like projection of desired height is formed to increase the rigidity of the reinforced panel. In addition, suitable fibers are selectively used to reinforce the reinforcing member in the longitudinal and transverse directions thereof. Therefore, it can be light and can be manufactured at low cost.

The heating of the reinforcing member can be done in a coating-drying furnace for an automotive vehicle body.

Also, rust-proofing and avoidance of local strain or partial sagging can be additionally achieved to further improve the strength of the panel.

When such a reinforcing member is employed on a panel, a relatively small volume of reinforcing member can reinforce the panel to a great extent so that the panel can be sufficiently reinforced and still be light.

Claims

1. A reinforcing member, comprising:

a reinforcing resin sheet (2) which is unhardened or semi-hardened so as to be flexible prior to its use, and which can be hardened to be rigid;

a high tensile-strength fiber for reinforcing the resin sheet (2) in its longitudinal direction;

a low tensile-strength fiber for reinforcing the resin sheet (2) in its transverse direction;

an expandable material (3), in a strip narrower than the resin sheet (2);

the expandable material (3) being flexible at least before the reinforcing member (1) is used;

the expandable material (3) being made of a material which can expand during the resin sheet hardening before the resin sheet hardens;

the expandable material (3) being fixed to the resin sheet (2);

the resin sheet (2) having its edge portions (21) extending beyond the expandable material (3) so that the edge portions (21) constitute surfaces (22) which can be affixed to the surface (A) to be reinforced.

2. The reinforcing member of claim 1, characterized in that the resin sheet (2) is made of a thermosetting resin material.

3. The reinforcing member of claim 1, characterized in that the resin sheet (2) is made of a resin which can be hardened at a room temperature.

4. The reinforcing member of claim 1, characterized in that the resin sheet (2) is made of a thermoplastic resin which has a predetermined strength at normal temperatures.

5. The reinforcing member of claim 1, characterized in that the fibers are embeded in the resin sheet (2).

6. The reinforcing member of claim 1, characterized in that the fibers are bonded onto the resin sheet (2).

7. The reinforcing member of claim 1, characterized in that the expandable material (3) is a foamable material which is flexible prior to its foaming and foamed by heating.

8. The reinforcing member of claim 1, characterized in that the expandable material (3) is replaced by corrugated cardboard.

9. The reinforcing member of claim 1, characterized in that the expandable material (3) is replaced by a rope.

10. The reinforcing member of claim 1, characterized in that the resin sheet (2) includes an outer layer (24) of a resin reinforced with fibers and an inner layer (25) of soft resin which can expand and harden to a predetermined degree.

11. The reinforcing member of claim 10, characterized in that a film (26) is bonded to the outer surface of the outer layer (24).

12. A panel, characterized by being reinforced by the reinforcing member as defined in claim 1.

13. The panel of claim 12, characterized in that the reinforcing member is placed between two high-rigidity portions of the panel for reinforcing the intermediate, low-rigidity portion thereof.

14. The panel of claim 12, characterized in that the panel is an outer panel of an automobile door.

Patentansprüche

1. Verstärkungsteil, mit
einer verstärkenden Harzschicht (2), die vor ihrer Verwendung ungehärtet oder halbgehärtet und damit flexibel ist und zu einem starren Zustand ausgehärtet werden kann;
Fasern hoher Zugfestigkeit zur Verstärkung der Harzschicht (2) in Längsrichtung;
Fasern geringer Zugfestigkeit zur Verstärkung der Harzschicht (2) in Querrichtung; und
einem expandierbarem Material (3) in Form eines Streifens, der schmaler ist als die Harzschicht (2); wobei
das expandierbare Material (3) zumindest vor der Verwendung des Verstärkungsteils (1) flexibel ist;
das expandierbare Material (3) aus einem Material besteht, welches während des Aushärtens der Harzschicht vor der Aushärtung der Harzschicht expandiert;
das expandierbare Material (3) an der Harzschicht (2) fixiert ist; und
die Randbereiche (21) der Harzschicht (2) sich über das expandierbare Material (3) hinaus erstrecken, so daß die Randbereiche (21) Oberflächen (22) bilden, die mit der zu verstärkenden Oberfläche (A) verbunden werden können.

2. Verstärkungsteil nach Anspruch 1, dadurch gekennzeichnet, daß die Harzschicht (2) aus einem hitzehärtbaren Harzmaterial besteht.

3. Verstärkungsteil nach Anspruch 1, dadurch gekennzeichnet, daß die Harzschicht (2) aus einem bei Raumtemperatur härtbaren Harz besteht.

4. Verstärkungsteil nach Anspruch 1, dadurch gekennzeichnet, daß die Harzschicht (2) aus einem thermoplastischen Harz besteht, welches bei normalen Temperaturen eine vorbestimmte Festigkeit besitzt.

5. Verstärkungsteil nach Anspruch 1, dadurch gekennzeichnet, daß die Fasern in die Harzschicht (2) eingebettet sind.

6. Verstärkungsteil nach Anspruch 1, dadurch gekennzeichnet, daß die Fasern an die Harzschicht (2) gebunden sind.

7. Verstärkungsteil nach Anspruch 1, dadurch gekennzeichnet, daß das expandierbare Material (3) ein schäumbares Material ist, das vor seinem Aufschräumen flexibel ist und durch Erhitzen aufschäumt.

8. Verstärkungsteil nach Anspruch 1, dadurch gekennzeichnet, daß das expandierbare Material (3) durch Wellpappe ersetzt ist.

9. Verstärkungsteil nach Anspruch 1, dadurch gekennzeichnet, daß das expandierbare Material (3) durch ein Seil ersetzt ist.

10. Verstärkungsteil nach Anspruch 1, dadurch gekennzeichnet, daß die Harzschicht (2) eine äußere Schicht (24) aus einem mit Fasern verstärkten Harz und eine innere Schicht (25) aus einem weichen Harz, welches zu einem vorbestimmten Ausmaß expandieren und aushärten kann, umfaßt.

11. Verstärkungsteil nach Anspruch 10, dadurch gekennzeichnet, daß die äußere Oberfläche der äußeren Schicht (24) mit einer Folie (26) verbunden ist.

12. Platte, dadurch gekennzeichnet, daß sie mit dem Verstärkungsteil nach Anspruch 1 verstärkt ist.

13. Platte nach Anspruch 12, dadurch gekennzeichnet, daß das Verstärkungsteil zwischen zwei Bereichen der Platte hoher Steifigkeit angeordnet ist, um den dazwischenliegenden Bereich geringer Steifigkeit zu verstärken.

14. Platte nach Anspruch 12, dadurch gekennzeichnet, daß die Platte die äußere Platte einer Automobiltür ist.

Revendications

1. Elément de renforcement, comprenant:
une feuille de résine de renforcement (2) qui est non durcie ou semi-durcie afin d'être flexible avant son utilisation, et qui peut être durcie pour être rigide;
une fibre de haut résistance à la traction pour renforcer la feuille de résine (2) dans sa direction longitudinale;
une fibre de faible résistance à la traction pour renforcer la feuille de résine (2) dans sa direction transversale;
un matériau dilatable (3), en une bande plus ètroite que la feuille de résine (2);
le matériau dilatable (3) étant flexible au moins avant d'utiliser l'élément de renforcement (1);
le matériau dilatable (3) étant fait d'un matériau qui peut se dilater pendant le durcissement de la feuille de résine avant durcissement de la feuille de résine;
le matériau dilatable (3) étant fixé à la feuille de résine (2);
la feuille de résine (2) ayant ses parties de bordure (21) s'étendant au-delà du matériau dilatable (3) de façon que les parties de bordure (21) constituent des surfaces (22) qui peuvent être fixées à la surface (A) à renforcer.

2. Elément de renforcement de la revendication 1 caractérisé en ce que la feuille de résine (2) est faite d'un matériau de résine thermodurcissable.

3. Elément de renforcement de la revendication 1 caractérisé en ce que la feuille de résine (2) est faite d'une résine qui peut être durcie à une température ambiante.

4. Elément de renforcement de la revendication 1, caractérisé en ce que la feuille de résine (2) est faite d'une résine thermoplastique qui a une résistance prédéterminée aux températures normales.

5. Elément de renforcement de la revendication 1 caractérisé en ce que les fibres sont noyées dans la feuille de résine (2).

6. Elément de renforcement de la revendication 1 caractérisé en ce que les fibres sont collées sur la feuille de résine (2).

7. Elément de renforcement de la revendication 1 caractérisé en ce que le matériau dilatable (3) est un matériau pouvant mousser qui est flexible avant sa mise en mousse et en ce qu'il mousse par chauffage.

8. Elément de renforcement de la revendication 1 caractérisé en ce que le matériau dilatable (3) est remplacé par du carton ondulé.

9. Elément de renforcement de la revendication 1 caractérisé en ce que le matériau dilatable (3) est remplacé par une corde.

10. Elément de renforcement de la revendication 1, caractérisé en ce que la feuille de résine (2) comprend une couche externe (24) d'une résine renforcée de fibres et une couche interne (25) de résine molle qui peut se dilater et durcir à un degrée prédéterminé.

11. Elément de renforcement de la revendication 10 caractérisé en ce qu'un film (26) est lié à la surface externe de la couche externe (24).

12. Panneau caractérisé en ce qu'il est renforcé par l'élément de renforcement tel que défini à la revendication 1.

13. Panneau de la revendication 12 caractérisé en ce que l'élément de renforcement est placé entre deux parties de haute rigidité du panneau pour renforcer sa partie intermédiaire de faible rigidité.

14. Panneau de la revendication 12 caractérisé en ce que le panneau est une panneau externe d'une porte d'automobile.

FIG.1

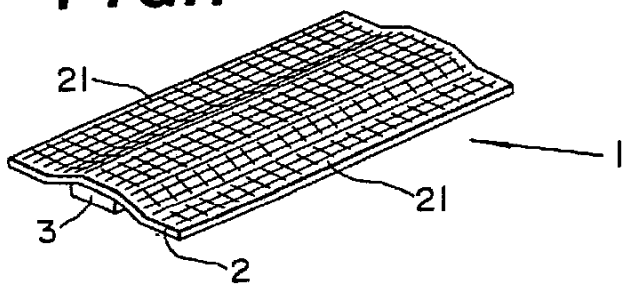

FIG.2(a)

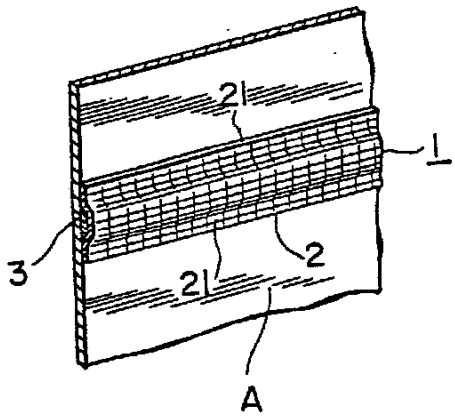

FIG.2(b)

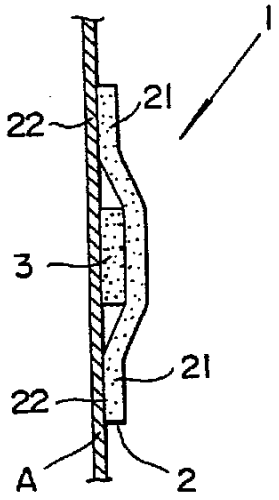

FIG.3(a)

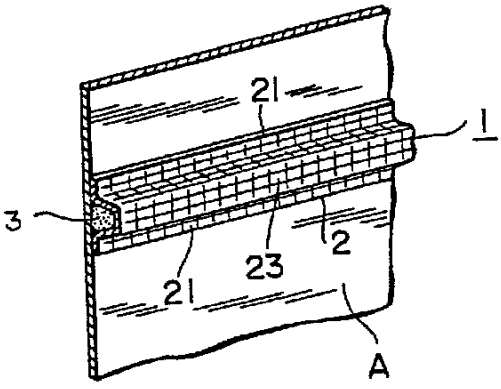

FIG.3(b)

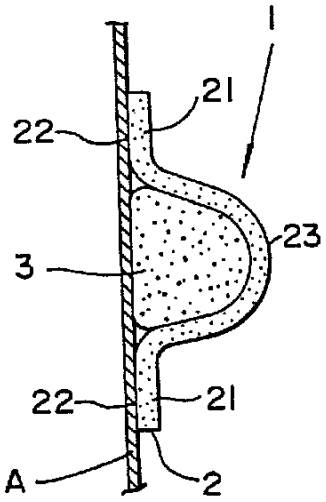

FIG.4(a)

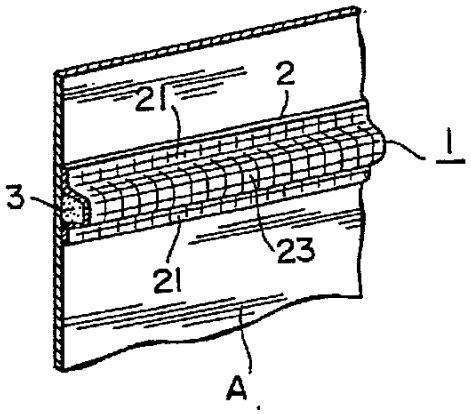

FIG.4(b)

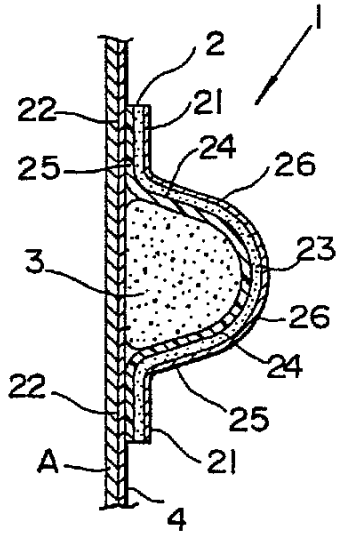

FIG.5

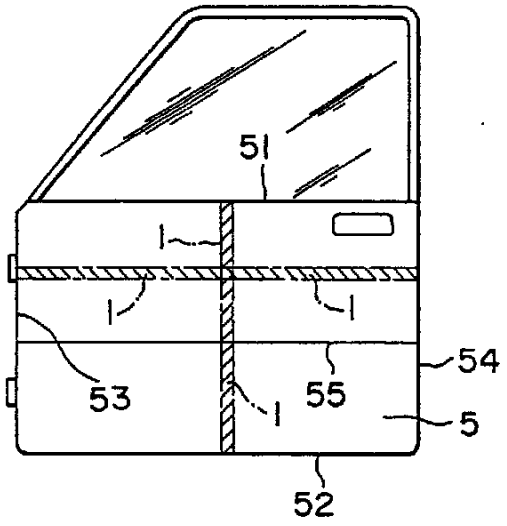

FIG.6

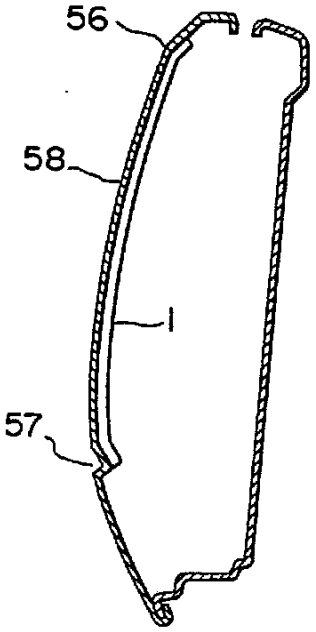

FIG.7